

Space Station Requirements for Electromagnetic Compatibility

International Space Station

Revision G
31 July 2002



NASDA

National Space Development
Agency of Japan



agenzia spaziale italiana
(Italian Space Agency)

National Aeronautics and Space Administration
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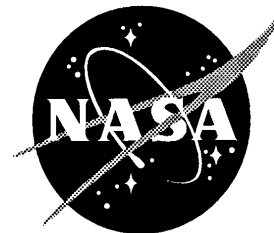
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REVISION AND HISTORY PAGE

REV.	DESCRIPTION	PUB. DATE
–	Baseline Issue (Reference SSCBD BB000830 Eff. 03–22–91)	03–30–91
A	Revision A (Reference SSCBD BM003057 Eff. 12–04–92)	01–93
B	Revision B (Reference SSCBDs BB003438 Eff. 05–17–83, BBO03499 Eff. 05–17–93, and BB003681 Eff. 05–28–93)	06–93
C	Revision C (Reference SSCBD 000002, Eff 2–7–94)	04–17–94
C1	Revision C1 (Comments Incorporated from PGs, IPs)	07–01–94
D	Revision D (SSCD 000263, EFF. 09–04–96) Revised to Transmittal from Freedom Program to ISS Changes Include Extensive Simplification of Requirements and Scope	01–29–97
	DCN 001 incorporates ECP 263 (Supplemental Release)	06–06–97
	DCN 002 incorporates SSCN 000777	07–21–98
E	Revision E incorporates SSCN 001102	07–29–98
	DCN 003 incorporates SSCN 001481	06–14–99
	DCN 004 incorporates SSCN 001662	08–25–99
	DCN 005 incorporates SSCN 002485	04–06–00
	DCN 006 incorporates SSCD 003213 Eff. 06–28–00	04–13–01
	DCN 008 incorporates SSCD 003746 Eff. 11–15–00	04–13–01
	DCN 010 incorporates SSCN 005263	10–23–01
	DCN 011 incorporates SSCN 005529	10–23–01
	The following DCNs have been cancelled. The content of these DCNs has been incorporated into Revision F. DCN 009 incorporates SSCN 000256 Administrative Cancel	
F	Revision F incorporates SSCN 004785	04–29–02
	The following DCNs have been cancelled. The content of these DCNs has been incorporated into Revision G. DCN 007 incorporates SSCN 003282 Administrative Cancel DCN 012 incorporates SSCN 006568 Administrative Cancel	
G	Revision G incorporates SSCN 003282, 006568, and 005820	12–06–02

PREFACE

This requirements document defines the International Space Station requirements for Electromagnetic Effects (EME) Control including provisions for control of the induced electromagnetic environment. Provisions are included for lightning effects, static electricity, bonding and grounding. This document is under the control of the Space Station Control Board.

SPACE STATION PROGRAM OFFICE

SPACE STATION REQUIREMENTS FOR ELECTROMAGNETIC COMPATIBILITY

31 JULY 2002

CONCURRENCE

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**SPACE STATION REQUIREMENTS
FOR ELECTROMAGNETIC COMPATIBILITY**

31 JULY 2002

For NASA

DATE

For ASI

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ESA Concurrence:
Reference SSP 50019 Joint Management Plan and
JESA 30000, Section 3, Appendix B

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SPACE STATION REQUIREMENTS FOR ELECTROMAGNETIC COMPATIBILITY**

LIST OF CHANGES

31 JULY 2002

All changes to paragraphs, tables, and figures in this document are shown below:

SSCBD	ENTRY DATE	CHANGE	PARAGRAPH(S)
6568	7/31/02	3.2.2	System, Subsystem and Equipment Requirements
		3.2.9	Static Electricity
3282		1.5	Electromagnetic Effects Panel
		2.0	Applicable Documents
		2.1	Reference Documents
		3.2.9	Static Electricity
		3.2.11	External Environment Effects
		3.3.2.1	Analytical Models
		3.5.1	EME Control Plan
		3.5.2	EMC Test Plan, Procedure, and Report
		3.6.2.1.1	Conditions to Start System-Level Testing
		3.6.2.1.5	Test Location Approval
		4.2	Waivers
5820		3.2.2	System, Subsystem and Equipment Requirements
		3.2.9	Static Electricity
			TABLE(S)
	7/31/02		None
			FIGURE(S)
	7/31/02		None
			APPENDIX
6558	7/31/02	Appendix A	Abbreviations and Acronyms
		Appendix F	Approved Tailoring/Interpretation Agreements
3282		Appendix A	Abbreviations and Acronyms
		Appendix C	Electromagnetic Effects Panel
		Appendix G	Payload EME Requirements
5820		Appendix F	Approved Exceptions

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1.0 GENERAL

The International Space Station (ISS) system requirement for Electromagnetic Effects Control (EMEC) shall be achieved by design within all segments, subsystems, and equipment within the ISS, by interface design with the National Space Transportation System (NSTS), and by design with the external electromagnetic environment.

1.1 INTRODUCTION

This requirements document establishes the Electromagnetic Effects (EME) process design and verification requirements for the ISS. The requirements of this document are applicable to hardware providers (HWP) including Space Station Flight Segments (SSFS), Ground System Segment (GSS), Government Furnished Equipment (GFE), Ground Support Equipment (GSE), Flight Support Equipment, Orbital Support Equipment (OSE), Payloads, and Commercial Off-the-Shelf equipment (COTS).

1.1.1 PRIME CONTRACTOR RESPONSIBILITIES

The Prime Contractor shall establish an overall integrated EME process for the ISS. The overall process shall include the necessary design, planning, technical criteria, and management controls needed to achieve overall EMEC and to ensure that the design and verification requirements specified herein are met. The ISS EME process shall be based on the requirements of SSP 30243 and the prime Statement of Work. The Prime Contractor shall direct each HWP to establish the technical effort and management controls necessary to accomplish their individual parts of the overall EMEC process.

1.1.2 HARDWARE PROVIDER RESPONSIBILITIES

HWPs shall have the responsibility for compliance with all requirements subsequent to 1.1.1 in accordance with the Prime Contractor's responsibilities of 1.1.1. The Prime Contractor shall be advised when compliance with these requirements compromises operational capabilities or when compliance will not ensure Electromagnetic Compatibility (EMC). The Prime Contractor shall be notified a minimum of 10 working days before any test start and shall have the option to witness the test.

1.2 PURPOSE

The purpose of this requirements document is to define a common electromagnetic design, control, test, and verification process for the ISS.

1.3 SCOPE

This document defines the ISS requirements for electromagnetic effects control including the responsibilities of all program participants for implementation, analysis, test, and verification.

1.4 INTENDED USE

This document is intended for use by the ISS. It is a requirement for the HWPs and, as determined, the International Partners (IP), including, in whole or part, their subcontractors.

1.5 ELECTROMAGNETIC EFFECTS PANEL

An Electromagnetic Effects Panel (EMEP) has been chartered by the Test and Verification Control Panel (T&VCP) as the management forum that oversees and reviews the program wide electromagnetic compatibility program, provides a resource for technical consultation and requirements interpretation, and provides a forum for resolving EME issues. The panel serves as the technical forum for maintenance of EME requirements and evaluation of reports and plans. This panel ensures HWPs establish uniform application of program EME requirements. The EMEP provides a means for expediting the solutions of technical problems and establishing channels for coordination. The details of operation for the EMEP are included in the EMEP charter, discussed in Appendix C of this document. The team is chaired by the NASA EME lead and cochaired by the Boeing EME lead. Members of the Team include representatives from Space Shuttle Program; Boeing, Houston; Space Station Hardware Integration Office, KSC; Operations Office, ISSP; Payloads Office, ISSP; Engineering Directorate, JSC; Safety and Mission Assurance/Program Risk Office, ISSP; Independent Assessment Office, ISSP; and NASA Frequency Management Office. Ad hoc members include the affected subsystem or technical discipline area requirement owner, NASA ISSP; the affected subsystem or technical discipline area requirement owner, Boeing ISSP; Affected Manager, ISSP Element; Affected Launch Package Manager; Mission Operations Directorate, JSC; and International Partners Representative(s).

1.6 PRECEDENCE

In the event of conflict between this document and any other Electromagnetic Interference (EMI) requirements document (e.g., SSP 30237, SSP 30238, SSP 30240, SSP 30242, and SSP 30245), this document shall take precedence.

In the event of conflict, the requirements of this document supersede those requirements in MIL-STD-1576 Basic Revision, July 31, 1984, and Notice 01, September 4, 1992, as applied to the ISS. The intent is to provide ISS specific clarification of the requirements of MIL-STD-1576 rather than replacement of those requirements.

2.0 APPLICABLE DOCUMENTS

The following applicable documents of the exact issue shown in the current issue of SSP 50257 form a part of this specification to the extent specified herein. Inclusion of applicable documents herein does not in any way supersede the order of precedence identified in paragraph 1.6. The references show where each applicable document is cited in this document.

DOCUMENT NO.	TITLE
NSTS-21000-IDD-ISS Paragraphs:	International Space Station Interface Definition Document 3.2.8.1, 3.2.8.2, 3.2.8.3
KSC-STA-61.01 Paragraph:	Space Station Processing Facility (SSPF) Facility and Equipment Design Plan (FEDP) 3.2.8.2
MIL-B-5087 Paragraph:	Bonding, Electrical, and Lightning Protection, for Aerospace Systems 3.2.2
MIL-STD-461 Paragraph:	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference 3.2.2
MIL-STD-1576 Paragraph:	Electroexplosive Subsystem Safety Requirements and Test Methods for Space Systems 3.2.10
MIL-STD-1686 Paragraph:	Electrostatic Discharge Control Program for Protection of Electrical And Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices) 3.2.9
SSP 30233 Paragraph:	Space Station Requirements for Materials and Processes 3.2.12
SSP 30237 Paragraphs:	Space Station Electromagnetic Emission and Susceptibility Requirements 1.6, 3.2.2, 3.2.11, 3.6.2.1.2
SSP 30238 Paragraphs:	Space Station Electromagnetic Techniques 3.2.2, 3.6.2.1.2
SSP 30240 Paragraphs:	Space Station Grounding Requirements 3.2.2, 3.2.7, 3.2.10, 3.6.2.1.2

DOCUMENT NO.	TITLE
SSP 30242 Paragraphs:	Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility 3.2.2, 3.2.5, 3.2.10, 3.6.2.1.2
SSP 30245 Paragraphs:	Space Station Electrical Bonding Requirements 3.2.2, 3.2.7, 3.2.10, 3.2.12, 3.6.2.1.2
SSP 30482, Volume 1 Paragraphs:	Electrical Power Specifications and Standards Volume 1: EPS Electrical Performance Specifications 3.2.6, 3.6.2.1.4
SSP 30482, Volume 2 Paragraphs:	Electrical Power Specifications and Standards Volume 2: Consumer Constraints 3.2.6, 3.6.2.1.4

2.1 REFERENCE DOCUMENTS

The following documents are referenced in this specification as a guide for context and user convenience. The references to these documents may not be listed in SSP 50257.

DOCUMENT NO.	TITLE
D684-10263-01	Electromagnetic Effects Verification Plan
MSFC-STD-531	High Voltage Design Criteria

3.0 REQUIREMENTS

3.1 DEFINITION OF ELECTROMAGNETIC COMPATIBILITY REQUIREMENTS

The system and all associated subsystem equipment, both on-orbit and ground, shall be designed to achieve electromagnetic compatibility. The HWP specification and interface documents shall contain supplementary requirements as necessary to achieve electromagnetic compatibility. As a minimum, the Tier I Contractors, Payload Providers, and IPs EME control process shall cover the following areas:

- Bonding and grounding
- Corona
- Degradation criteria
- Electrical power and electrical interface
- EMI safety margins for critical equipment
- EME analysis requirements and methodologies
- External environment effects
- Interactions with other technologies including, but not limited to, functionality, maintainability, plasma, reliability, materials and processes, and safety
- Interference and susceptibility control
- Launch element transportation, storage, handling, and launch environments
- Lightning protection
- Material and processes
- Personnel hazards
- Pyrotechnics and Bridge Wire Actuated Devices
- Spacecraft charging controls
- Static electricity
- Subsystem compatibility
- Subsystems and equipment requirements
- Wiring and cable

3.2 CHARACTERISTICS

3.2.1 SYSTEM AND SUBSYSTEM COMPATIBILITY

Compatibility shall be demonstrated between system and subsystems by functionality with the required safety margin. The GSS, along with training devices and simulators, shall be designed for compatibility.

3.2.2 SYSTEM, SUBSYSTEM, AND EQUIPMENT REQUIREMENTS

The ISS system, segments, subsystems, and equipment shall be designed to meet the requirements of this document. Electrical and electronic equipment, as mounted and enclosed (including racks, nonconductive mounting, cold plate mounting, portable enclosures, etc.), shall meet the requirements of SSP 30237 when tested in accordance with SSP 30238. Electrical grounding shall meet the requirements of SSP 30240. Electrical bonding shall meet the requirements of SSP 30245. Electrical cable design shall meet the requirements of SSP 30242. GSE for Product Group (PG) only shall meet the requirements of MIL-STD-461 and MIL-B-5087. Approved EME waivers shall be included in the HWPs EME Design Analysis Report. See appendix F for exceptions (EMECB Tailoring Interpretation Agreement (TIA)-0060, EMECB TIA-0061, EMECB TIA-0092, EMECB TIA-0195, EMECB TIA-0196, EMEP TIA-0233, EMEP TIA-0384, EMEP TIA-0419, and EMEP TIA-0420) to this paragraph.

3.2.3 ELECTROMAGNETIC INTERFERENCE SAFETY MARGINS FOR CRITICAL CIRCUITS

Circuits implementing critical functions such that incorrect operations due to EMI could result in loss of life or loss of ISS shall be demonstrated to have an EMI safety margin of 6 dB by test or 20 dB by analysis. For analyses in which the EMI safety margin is in part established by measured emission or susceptibility characteristics, margins of 10 dB shall be demonstrated. EMI safety margins for firing circuits of critical electroexplosive devices (see 3.2.10 for exploding bridgewire type devices) shall be demonstrated to be 20 dB by test or 34 dB by analysis. See appendix F for exception (EMECB TIA-0091) to this paragraph.

3.2.3.1 INTERFERENCE AND SUSCEPTIBILITY CONTROL

The ISS subsystems and equipment shall function with the required margins identified in 3.2.3 when subjected to EMI produced by any of the subsystems or equipment associated with the system. This shall be accomplished through design. Verification shall be by analysis and tests as specified in this document.

3.2.4 DEGRADATION CRITERIA

Degradation criteria shall be established by the HWP for each system, subsystem, and equipment. These criteria shall be used to define and evaluate malfunctions, unacceptable, and undesirable responses.

3.2.5 WIRING AND CABLING DESIGN

Wiring and cabling shall be designed in accordance with SSP 30242. Wiring and cabling shall be selected, classified, and bundled in accordance with the requirements and procedures in SSP 30242. Cables, wires, and cable and wire bundles shall be located and routed to provide a 20 dB cable to cable coupling loss using physical or electrical separation and considering the worst case steady state or transient conditions. Cable design shall include provisions for termination of shielded wires in accordance with SSP 30242. Connectors used to carry wires with overall shields shall use a conductive finish and shall use a back shell that provides for peripheral bonding of shields. Wire or cable shall be categorized according to interference and susceptibility characteristics in accordance with the requirements of SSP 30242. Wires and cables shall be marked in such a manner that personnel can visually identify the EMC category for each wire or cable. The end to end path of each and every wire and cable conductor shall be documented and the cable bundle, physical path, and wire code (color, marking, classification, size, type, etc.) shall be identified to support EME design analysis as well as maintenance and growth.

3.2.6 ELECTRICAL POWER AND ELECTRICAL INTERFACE

The ISS system, subsystems, and equipment shall not malfunction, or have unacceptable responses due to surges, ripples, voltages, and other electrical conditions that can cause interference or susceptibility, when supplied with electrical power conforming to SSP 30482.

3.2.7 BONDING AND GROUNDING

Bonding and grounding provisions shall be in accordance with SSP 30240 and SSP 30245.

3.2.8 LAUNCH ELEMENT TRANSPORTATION, STORAGE, AND LAUNCH ENVIRONMENT

3.2.8.1 LAUNCH

The ISS launch element shall be designed such that inadvertent action or failure will not occur when subject to the payload bay lightning induced environment resulting from a lightning strike to the NSTS as defined in NSTS-21000-IDD-ISS.

3.2.8.2 TRANSPORTATION AND STORAGE

The HWP electromagnetic environment during transportation and storage of the launch element shall be controlled in accordance with KSC-STA-61.01 and shall not exceed the launch environment defined in NSTS-21000-IDD-ISS.

3.2.8.3 TRANSITION PHASE

The ISS launch element during transition to orbit shall not exceed or be susceptible to electromagnetic environments defined in NSTS-21000-IDD-ISS.

3.2.9 STATIC ELECTRICITY

Unpowered electronic equipment and components shall not be damaged by Electrostatic Discharges (ESD) equal to or less than 4000 volts to the case or to any pin on external connectors. Equipment that may be damaged by ESD between 4000 and 15000 volts must have a label affixed to the case in a location clearly visible in the installed position. Handling of equipment susceptible to ESD up to 15000 volts shall be in accordance with MIL-STD-1686. These voltages are the results of charges that may be accumulated and discharged from ground personnel or crew members during equipment installation or removal. When testing or analysis for ESD susceptibility is performed, the ESD hazard from personnel shall be simulated by charging a 100 picofarad capacitance and discharging it through a 1500 ohm resistor. See appendix F for the exceptions (EMECB TIA-0042, EMEP TIA-0230, EMEP TIA-0248, EMEP TIA-0274, EMEP TIA-0289, EMEP TIA-0290, EMEP TIA-0302, EMEP TIA-0367, EMEP TIA-0369, EMEP TIA-379, and EMEP TIA-0422) to this paragraph.

3.2.10 ELECTROEXPLOSIVE DEVICES

The system design shall conform to the requirements of MIL-STD-1576 as modified by appendix E and shall include provisions to protect Electroexplosive Devices (EED) from inadvertent ignition or dudding caused by any form of electromagnetic or electrostatic energy. All wiring, cabling, and hardware associated with the EEDs shall be designed to prevent stray pickup and eliminate undesired energy. Safety margin requirements for EEDs are defined in 3.2.3. Grounding and bonding requirements for EEDs shall meet the requirements of SSP 30240 and SSP 30245. Wiring requirements for EEDs are defined in SSP 30242.

3.2.11 EXTERNAL ENVIRONMENT EFFECTS

System, subsystem, equipment, and component designs shall analyze and document potential failures caused by external electromagnetic environments. The external electromagnetic environments are defined in SSP 30237 or D684-10263-01.

3.2.12 MATERIALS AND PROCESSES

Materials and processes shall conform to the electrical and electronic requirements of SSP 30233 and as supplemented in SSP 30245.

3.2.13 CORONA

Electrical and electronic subsystems, equipment, and systems shall be designed to preclude damaging or destructive corona in any ISS operating environment. An analysis shall be provided to verify the corona shall not create damaging or destructive effects. See appendix F for the exceptions (EMEP TIA-0274, EMEP TIA-0291, EMEP TIA-0304, and EMEP TIA-0316) to this paragraph.

3.3 ANALYSIS

3.3.1 ANALYSIS REQUIREMENTS

Subsystems shall be analyzed for EME to support:

- Quantitative evaluation of proposed designs and design changes.
- Specification tailoring and waiver evaluation.
- Test result assessments.
- Verification test planning and critical test point selection.
- Quantitative assessment of the ISS function safety margins for configuration changes.

3.3.2 ANALYTICAL MODELS AND METHODS

3.3.2.1 ANALYTICAL MODELS

Analytical models used to perform and support analyses provided in the Design Analysis Report (DAR) shall be described in sufficient detail in the DAR to support technical evaluation by the EMEP. Use of model software tools such as IEMCAP, SEMCAP, and ISEAS which provide integrated system analyses, shall be permitted along with analyses performed with general purpose problem solving tools, such as MATHEMATICA, MATLAB, MATHCAD and spreadsheets. Appendix D is the methodology used by the EMEP to perform integration analysis of the Space Station.

3.4 GFE AND COMMERCIAL OFF-THE-SHELF EQUIPMENT

3.4.1 SELECTION AND USE OF EQUIPMENT

3.4.1.1 COMMERCIAL OFF-THE-SHELF EQUIPMENT

When COTS equipment is considered for use, the following rules shall be used in selecting and utilizing the equipment in the system:

- The equipment shall be considered adequate if emission and susceptibility test data are available to demonstrate compatibility.
- When compliance with interference requirements cannot be substantiated due to unavailability of test reports, then laboratory interference tests shall be performed for qualification of the subsystem as negotiated with the responsible authority for the equipment.
- If it is determined that more stringent requirements are necessary after evaluation of available data, it shall be the responsibility of the procuring authority to direct the supplier to implement these requirements or to select another equipment with adequate characteristics.

3.4.1.2 GOVERNMENT FURNISHED EQUIPMENT

GFE that is required for use in the system shall be acceptable from an EME viewpoint, provided the interference and susceptibility requirements as outlined below are met:

- As a minimum, subsystem and equipment designs must have met the EMI safety margin requirements of this document and be supported by approved qualification test reports.
- When compliance with applicable specifications cannot be substantiated, laboratory tests shall be performed for qualification of systems, subsystems, or equipment to the applicable requirements as negotiated with the responsible flight element, system, or subsystem authority.
- GFE which cannot meet the requirements and for which external suppression measures are ineffective shall be modified if approved by the responsible flight element, system, subsystem, or equipment procuring authority. If such procedures are not specified, the flight element, system, subsystem, or equipment supplier shall advise the responsible authority by a timely letter of systems, subsystems, or equipment that cannot meet the requirements and of pertinent details concerning the modifications required.
- When GFE is demonstrated to cause interference that cannot be eliminated by proper installation, control of the system electromagnetic environment, or by reasonable modification to the flight element, system, subsystem, or equipment, then NASA shall have the authority to waive the requirement.

3.5 DOCUMENTATION

3.5.1 EME CONTROL PLAN

Each Tier I Contractor, Payload Provider, and IP shall submit an EME Control Plan to the EMEP. The EME Control Plan shall include details describing element, system, subsystem, and equipment control processes. Verification planning including tests and analysis shall be summarized in the EME Control Plan.

3.5.2 EMC TEST PLAN, PROCEDURE, AND REPORT

Each Tier I Contractor, Payload Provider, and IP, shall submit an EMC Test Plan, Procedure, and Report to the EMEP. The EMC Test Plan shall include details as defined in the International Technical Agreements and PG Supplier Data Requirements Lists.

3.5.3 EME DESIGN ANALYSIS REPORT

Each Tier I Contractor, Payload Provider, and IP shall submit an EME DAR. The EME DAR shall include details and conditions for the element, system, subsystem, and equipment included in the deliverable end item. In addition to the DAR, each HWP shall provide configuration data, analysis data, and test results data to the Prime Contractor in the detail and format as defined for the EME Configuration, Analysis, and Test Data Base (appendix D). For International Partners the detail and format of these data exchanges are defined in the Bilateral Data Exchange Agreements.

3.5.4 EMI TEST PLANS, PROCEDURES, AND REPORTS

HWPs shall provide EMI test plans, procedures, and reports.

3.6 VERIFICATION

3.6.1 VERIFICATION METHODS

Flight element, systems, subsystems, and equipment compatibility shall be verified by a combination of tests, demonstrations, analyses, and inspections.

3.6.2 INTEGRATION TESTS

3.6.2.1 DELIVERABLE END ITEM COMPATIBILITY TEST

Tier I Contractors, Payload Providers, and IPs shall perform a system EMC test on the highest level deliverable end item package. The test shall include:

- A functional compatibility demonstration to verify that the deliverable end item equipment is selfcompatible.
- An interface test with simulated sources and loads to show that circuits interfacing with the next highest level of assembly function compatibly with the interface (including grounding and bonding).
- Safety margin tests where margins have not been previously determined by equipment level tests or analyses.

3.6.2.1.1 CONDITIONS TO START SYSTEM-LEVEL TESTING

Outstanding approved engineering orders, engineering change proposals, modifications, and configuration changes applicable to the end item components shall have been incorporated and installed prior to test. Requests for exceptions shall contain supporting rationale for tests of substandard configurations and shall be submitted to the EMEP for approval.

3.6.2.1.2 COMPLIANCE

Equipment components of the end item shall be complied with applicable equipment level EMI and EMC specifications (SSP 30237, SSP 30238, SSP 30240, SSP 30242, and SSP 30245) or have approved waivers allowing the specification exceptions.

3.6.2.1.3 TEST PLAN

Tests shall not be conducted without an approved test plan.

3.6.2.1.4 POWER QUALITY

External electrical power supplied to the flight element, system, or subsystem, under test shall simulate the power quality requirements and interface (including dynamic impedance) requirements of SSP 30482. The end item compatibility test will be performed with its input power set to the worst case input voltage levels (i.e., the high limit, nominal level, or low limit) called out in SSP 30482.

3.6.2.1.5 TEST LOCATION APPROVAL

Tests shall not be conducted where the electromagnetic environment at the test site would affect the validity of the tests. The location and environment of the test site shall be included in the test plan and submitted for approval to the EMEP.

3.6.2.1.6 TEST ITEM OPERATING ADJUSTMENTS

During tests, all electronic flight elements, systems, subsystems, and equipment under control of crew or ground operations personnel shall be adjusted within the limits of the test article specification(s) for nominal operating conditions (i.e., a receiver squelch circuit shall be set to its normal operating position and not to extreme positions) to provide indication of interference or susceptibility consistent with planned operation.

3.6.2.1.7 COMPATIBILITY

Tests shall be performed to indicate compatible operation, undesirable responses, unacceptable responses, or malfunctions while all flight elements, systems, subsystems, and equipment are operated. It shall be the responsibility of the supplier to determine conclusively and correctly the causes of noncompatibility (i.e., the source(s), coupling paths, and susceptible components) in order to support hardware and software fixes, operational workarounds, or preparation of waiver requests.

3.6.2.1.8 INSTRUMENTATION

Each EME test shall be monitored by appropriate means to assure adequate recording of measured data used to evaluate the effects of test article operation and demonstrate the required safety margins. Instrumentation used shall be specified in the test plan.

3.6.2.1.8.1 INSTRUMENTATION MEASUREMENT STANDARDS

Instrumentation shall meet or exceed measurement standards traceable to standards maintained by the National Institute of Standards and Technology or other value(s) derived from a controlled measurement process utilizing a fundamental constant of nature.

3.6.2.1.9 OPERATING MODES

The overall system shall be operated in representative modes of operation as defined in the test plan. Representative modes including programmed missions, flight, and stage assembly shall be used. Known worst case modes as determined by analysis shall be included in the test plan.

3.6.2.1.10 SIMULATED INTERFACES

When test articles require simulation of interfaces with equipment not the responsibility of the supplier, or where special inputs are required, the means of simulating these interfaces shall be described in the test plan.

3.6.2.1.11 GENERAL CONDITIONS

The EMC tests shall demonstrate required compatibility when flight elements, systems, subsystems, equipment, including GSE, and simulators are individually or collectively operated in representative modes of operation. Transmitters and receivers shall be operated at those critical frequencies identified during system analysis and laboratory tests. Multichannel transmitters and receivers shall be tested at a representative number of frequencies usually not less than 20. If the system uses special frequencies for command channels, distress messages, or other purposes, the frequencies shall be given special attention.

3.6.2.1.12 ACCEPTANCE CRITERIA

Compliance with this requirements document shall be achieved when compatible operation of the test item is demonstrated along with the existence of the required safety margins at designated critical circuits.

3.6.2.1.13 TEST SITE AMBIENT ELECTROMAGNETIC ENVIRONMENT

The electromagnetic ambient environment at the end item test site shall be measured, recorded, and analyzed to ensure that the ambient environment does not degrade test results or mask interference from the test article. The environment shall be monitored periodically during the test and shall be controlled to the extent necessary to prevent test degradation (i.e., by shutting off local external sources or conducting the test during times when the local external sources are not present). Ambient signals (both steady state and transient) shall be considered as a possible source of interference and will be measured when end item functions cannot be positively identified as interference sources.

3.6.3 TEST ANALYSIS

Test analyses shall be performed as necessary to utilize the end item, equipment, subsystem, and equipment test data in support of verification of the EMC requirements.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 RESPONSIBILITY FOR INSPECTION

Unless otherwise specified, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may use his own facilities or any other commercial laboratory acceptable to the Prime Contractor.

4.2 WAIVERS

Either one of two courses of action may be taken when an ISS flight element or launch package does not meet its EME requirements:

- The discrepancy shall be corrected such that the equipment complies with the requirements.
- An analysis shall be performed to assure that system EMC is not degraded, including the flight element itself or any other part of the ISS or launch package.

Requests for waivers shall be prepared for submittal to the EMEP for approval. Preparation and execution of the waiver requests shall be in accordance with the ISS waiver request format and procedure. Waiver requests shall be accompanied by technical analysis and process rationale relative to granting the waiver. The analyses supporting waiver requests also shall verify that the end item equipment meets its required safety margins. The analysis shall address whether the indicated out of tolerance condition will be detrimental to the ISS operation.

APPENDIX A ABBREVIATIONS AND ACRONYMS

AIT	Analysis Integration Team
ARIS	Active Rack Isolation System
ASCII	American Standard Code for Information Interchange
AUI	Attachment Unit Interface
CAT	Configuration, Analysis and Test
CATDB	Configuration, Analysis and Test Database
CD	Computer Disk
CI	Configuration Item
COP	Common On-chip Processor
COTS	Commercial Off-the-Shelf
CPDS	Charged Particle Directional Spectrometer
DAR	Design Analysis Report
dB	Decibel
dc	direct current
ECG	Electrocardiogram
EED	Electroexplosive Device
EMC	Electromagnetic Compatibility
EME	Electromagnetic Effects
EMEC	Electromagnetic Effects Control
EMECB	Electromagnetic Effects Control Board
EMEP	Electromagnetic Effects Panel
EMI	Electromagnetic Interference
EPCE	Electric Power Consuming Equipment
ESD	Electrostatic Discharge
ESSMDM	Enhanced Space Station MDM
EUE	Experiment Unique Equipment
GFE	Government Furnished Equipment
GSE	Ground Support Equipment
GSS	Ground System Segment
GUI	Graphics User Interface
HRDL	High Rate Data Link
HRF	Human Resource Facility
HWP	Hardware Provider (any provider of hardware to the ISS program)
Hz	Hertz

ICD	Interface Control Document
IEMCAP	Software for computer aided analysis of EMC
I/O	input and output
IMR	Internal Management Review
IP	International Partner
IPT	Integrated Product Team
ISEAS	Integrated Space Station EMC Analysis System (analysis software)
ISS	International Space Station
IVA	Intravehicular Activity
kHz	kilohertz
KSC	Kennedy Space Center
LED	light emitting diode
m	milli
MACE	Module Access Certification Equipment
MATHEMATICA	General purpose mathematical analysis software
MATLAB	General purpose mathematical analysis software
MATHCAD	General purpose mathematical analysis software
MC	Master Controller
MDM	multiplexer/demultiplexer
MHz	megahertz
NASA	National Aeronautics and Space Administration
NSTS	National Space Transportation System
ORU	Orbital Replacement Unit
OSE	Orbital Support Equipment
PEHG	Payload Ethernet Hub Gateway
PFM	Pulse Frequency Modulation
PG	Product Group
PN	Part Number
PuFF	Pulmonary Function In Flight
RF	Radio Frequency
RIC	Rack Interface Controller
RID	Rack Insertion Device
SEMCAP	System EM Compatibility Analysis Program
SSMMU	Solid state mass memory unit

T&VCP	Test and Verification Control Panel
TBD	To Be Determined
TEPC	Tissue Equivalent Proportional Counter
TIA	Tailoring/Interpretation Agreement
TPA	Tilt Platform Assembly
USL	United States Laboratory
V	Volt
VMDB	Vehicle Master Database
VTR	Video Tape Recorder

APPENDIX B GLOSSARY

ELECTROMAGNETIC COMPATIBILITY

The capability of systems and all associated subsystems and equipment to perform within design limits without degradation due to the electromagnetic effects encountered during accomplishment of the assigned mission.

ELECTROMAGNETIC EMISSIONS

Electromagnetic energy radiated or conducted from an electrical or electronic component, equipment, subsystem, system, or flight element.

ELECTROMAGNETIC ENVIRONMENT

The composite natural and induced sum of the electric and magnetic fields at any point due to man made and natural sources to which a system or subsystem or equipment will be exposed during a mission.

ELECTROMAGNETIC INTERFERENCE

Any electromagnetic disturbance, phenomenon, signal, or emission (man made or natural) which causes equipment performance outside of the equipment's design limits.

ELECTROMAGNETIC SUSCEPTIBILITY

Equipment capability for impaired performance due to electric or magnetic environments (radiated or conducted).

EMI MALFUNCTION

A failure of a system or associated subsystem and equipment due to electromagnetic interference or susceptibility that results in a loss of function, mishap, mission abort, or failure to accomplish mission.

RECEIVER AREA NOISE LEVEL

The receiver area electrical noise level at a particular frequency that is receiver output obtained with all controls at standard settings with all other subsystems and equipment turned off, receiver antenna connected, and the intended signal not present.

SUBSYSTEM

A collection of equipment designed to work together. The subsystem contributes to the system functionality and does not stand alone.

SYSTEM

A collection of equipment, subsystems, skills, and techniques capable of performing or supporting an operational role. A complete system includes related facilities, equipment, subsystems, materials, services, and personnel required for operation to the degree that the system can be considered autonomous within the operational environment.

UNACCEPTABLE RESPONSE

An abnormality in the operation or output of a subsystem or equipment due to electromagnetic interference.

UNDESIRABLE RESPONSE

A recognized distortion or perturbation of normal output of equipment, subsystem, or system which is considered tolerable by the procuring activity.

APPENDIX C ELECTROMAGNETIC EFFECTS PANEL

C.1 PURPOSE

This document defines the EMEP that serves as the technical forum for maintenance of EME requirements, plans, and reports and for resolving issues relative to electromagnetic environmental effects on the ISS system. This charter defines details necessary for the EMEP to support the design review and integration of technical activities associated with the electromagnetic effect. The NASA and Boeing Leads for EME are designated as cochairpersons.

C.2 SCOPE

The EMEP is responsible for the technical guidance and timely resolution of technical issues related to environmental electromagnetic effects and EME requirements, maintenance, and compliance verification of the ISS. The primary focus of the team is to resolve electromagnetic issues and achievement of the required systems performance. This includes the evaluation of TIA requests for relaxation of EME requirements and data exchange between appropriate elements and disciplines to ensure that the optimum overall ISS level, system level, and user accommodation requirements related to this environment are incorporated in the design.

C.3 AUTHORITY

The EMEP is the counterpart of the EMC Advisory Board described in MIL-E-6051D, the electromagnetic effect control process used in other government programs. It will obtain the benefit of skills available across the program to provide specific expertise for coordinating integration of the electromagnetic effect. The EMEP provides the mechanism by which the NASA and Boeing cochairpersons assure, the active participation of supporting organizations in EME matters. The EMEP is responsible for activities of working groups it establishes.

C.4 RESPONSIBILITIES

C.4.1 EMEP RESPONSIBILITIES

Certain specific responsibilities of the EMEP are identified in the following paragraphs:

- A. Provide technical evaluation of the EME compatibility process status and the EME concerns.

- B. Participate in program reviews for EME disciplines. Facilitate communications among team members and their organizations.
- C. Coordinate assessments of Tier I subcontractor EME control plans, test and analysis plans, and test and analysis reports.
- D. Modify and update the program specific environmental discipline requirements documents and specifications when necessary. Evaluate and recommend disposition of EME waiver requests.
- E. Coordinate Prime Contractor assessment of EME verification documentation and implement processing of the recommended actions by the proper management channels.
- F. Ensure that legal requirements related to electromagnetic effects are addressed.
- G. Support development of user accommodation requirements for specific environments disciplines. Review, update, and evaluate the ISS Radio Frequency (RF) environment.
- H. Coordinate follow up oversight to ensure timely and appropriate implementation of EMEP action items. Review and evaluate the electromagnetic effects of the interactions with the Space Shuttle and review Space Shuttle requirements for compliance. Recommend changes to the ISS and Space Shuttle requirements or operations as needed.
- I. Review and evaluate EME requirements of other spacecraft that may interface with the ISS to ensure compliance with ISS EME requirements.
- J. Coordinate the definition of system level requirements for controlling and monitoring the electromagnetic effect.
- K. Conduct studies dealing with issues affecting or effected by the electromagnetic effect.
- L. Maintain current definitions of the combined natural and induced electromagnetic effect in the proximity of the ISS.
- M. Evaluate future changes for the electromagnetic effect and define models, tools, and databases required for assessment of the electromagnetic effect and electromagnetic plasma interactions during the design and operational phases of the ISS.

- N. Assure that the electromagnetic effect is adequately defined, consistent with other environments definitions, and accurately reflected in the appropriate documents and designs.
- O. Identify technical issues associated with the electromagnetic effect definition and develop recommendations for resolution of issues to forward to the Internal Management Review (IMR) for subsequent introduction into the Configuration Management process.
- P. Provide support to formal design reviews, Space Station Control Board activities, and other panel and working groups as required.
- Q. Review development status of electromagnetic effect requirements for stages and interfaces to assure adequate coordination and flow of information across technical interfaces.
- R. Develop user accommodation requirements related to the electromagnetic effect definition and the ISS design.

C.4.2 RESPONSIBILITIES OF PRESENTERS AT PANEL MEETINGS

The presenter of materials is responsible for coordination of issues that affect other program participants prior to presentation. Members are responsible for providing feedback to presenters on significant aspects of the issues.

C.4.3 RESPONSIBILITIES OF THE COCHAIRPERSONS

A goal of the EMEP is to achieve consensus on each issue. However, the EMEP cochairpersons will be the final authority for decisions concerning actions items, recommendations to Integrated Product Teams (IPT) or AITs on change requests, TIAs, and resolution of issues. Decisions will be documented and issued within 48 hours of the decision. If a contract adjustment is required, the respective project office and the EMEP cochairpersons shall be notified within 5 calendar days of receipt of the decision.

Appropriate action shall be taken by pertinent project offices to resolve contractual issues as soon as practicable. If necessary, the EMEP may reconsider issues because of the severity of the impacts.

The cochairpersons shall present EME discipline issues and status to the AITs or IPTs as appropriate. The EMEP cochairpersons shall present requirements changes and TIAs to the T&VCP for review.

C.5 MEMBERSHIP

Membership of the EMEP shall consist of the cochairpersons (cochaired by the NASA EME lead and the Boeing Contractor EME lead) and members appointed by the members' parent organization for the following organizations:

- Boeing, Houston
- Space Shuttle Program
- Space Station Hardware Integration Office, KSC
- Operations Office, ISSP
- Payloads Office, ISSP
- Engineering Directorate, JSC
- Safety and Mission Assurance/Program Risk Office, ISSP
- Independent Assessment Office, ISSP
- NASA Frequency Management Office

Ad hoc members include:

- Affected subsystem or technical discipline area requirement owner, NASA ISSP
- Affected subsystem or technical discipline area requirement owner, Boeing ISSP
- Affected Manager, ISSP Element
- Affected Launch Package Manager
- Mission Operations Directorate, JSC
- International Partners Representative(s)

C.6 PROCEDURES

Operating procedures are given in the following paragraphs:

- A. The EMEP will meet as needed. Meetings may be called on an as required basis by the EMEP cochairpersons. Maximum use will be made of teleconferences and video conferences.
- B. The EMEP will normally meet biweekly. The meeting frequency will be determined by the cochairpersons. Partial membership meetings may be called on an as required basis by the cochairpersons. Maximum use will be made of teleconferences and video conferences.

- C. The meeting agenda will be established by the cochairpersons, coordinated with appropriate members, and distributed three working days in advance of the meeting.
- D. Copies of the presentation materials will be provided before the meeting to individuals that will participate via teleconference or video conference.
- E. Action items resulting from the meeting shall be assigned by the EMEP cochairpersons with the concurrence of the assignees. These action items will be distributed to actionees within four working days of the meeting date.
- F. Minutes of the meeting will be prepared and distributed within five working days of the meeting's end date. When possible, the minutes will be distributed with the action items.
- G. Copies of the material presented at the meeting will be available at the meeting through the cochairpersons upon request, but will not be provided with the minutes.

APPENDIX D EME CONFIGURATION, ANALYSIS, AND TEST DATABASE

D.1 PURPOSE

An ISS EME Configuration, Analysis, and Test DataBase (CATDB) is being developed to allow technical integration of the ISS electromagnetic effect. This analysis will confirm the electromagnetic compatibility of the ISS. The CATDB will provide the formatted outputs that will be used as input data for analytical tools such as ISEAS or IEMCAP. The CATDB will contain ISS EME related equipment and end item hardware configuration, analysis and test (CAT) data. This data will include wiring and shielding configuration, equipment location and orientation (i.e., for cases, racks, connectors, antennas, sensors, etc.), frequency and amplitude characteristics for emitters and receivers, and other data from the EMC and EMI test reports. The CATDB will allow ad hoc queries from the PGs and IPs through the Vehicle Master DataBase (VMDB).

D.2 DATABASE STRUCTURE

The Prime will assemble and maintain the CATDB with data and support from the PGs, IPs, and providers of GFE and payloads. The CATDB structure will be defined by the Prime and will be revised as necessary to reflect changes in EME technical integration needs. The CATDB will utilize a Relational Model using Structured Query Language to facilitate use and query of the database by nondatabase specialists and to facilitate electronic transfer of data to and from other databases. Data in the CATDB will be updated periodically to reflect EME related details of ISS documentation, configuration, wiring, cabling, and equipment. The CATDB will incorporate on going analysis data and test data regarding emissions, susceptibilities, and safety margins of the equipment and end items as the data becomes available.

D.3 VMDB RELATIONSHIP

The CATDB is a tool which draws data from the VMDB. All configuration, analysis, and test data required by the Prime will reside within the VMDB. The VMDB has a library function and a Graphics User Interface (GUI). The library function allows the VMDB to store and retrieve additional data that contains useful information about the equipment or end item provided. The GUI is used to view graphics and drawings associated with the data.

D.4 DATA PROVIDERS TASKS

There are several tasks required from the providers to enable the CATDB to be fully useful and effective for the ISS community. These are tasks that provide the collection of the data to populate the different fields of the database.

- A. Data Provider task one is to provide periodic level of effort aid and assistance to the Prime in:
- (1) Identifying and acquiring access to on line databases used in the description, manufacture, assembly, and tracking of the ISS equipment, wiring, and end item installation details.
 - (2) Identifying and providing data from cable schematics, assembly drawings, descriptions, installation locations, and other installation details and acquiring access to on line utilities providing hard copies of these items and, in some instances, access to selected data in databases supporting the utilities. This data should be provided in a format compatible with the CATDB.
- B. Data Provider task two is to provide files or on line transmittal in American Standard Code for Information Interchange (ASCII) format for data on graphs of equipment and end item measured test data used in EMC test reports. The units of the data series (i.e., dB/mVolt versus Hz, dB/mVolt/meter versus MHz, etc.), along with the title and date of the test report and the date of the measurement, if available, shall be included in the header of the file using a format negotiated with the Prime.
- C. The data providers should contact their spectrum analyzer and instrument suppliers for software and hardware solutions for ASCII outputs of measured data.

D.5 CAT DATA ATTRIBUTES AND TRACEABILITY

CAT data attributes and traceability shall be provided in each data provider submittal. These traceability attributes shall include the data source (i.e., drawing, test report, analysis report, manufacturer, etc.), title, revision number, and date. The inclusion of other data attributes which the data providers find useful shall be permitted.

D.6 CAT DATA TRANSMITTAL

CAT data and drawings will be submitted in the following format:

- A. All drawings shall be delivered in a CCIT Group 4 Raster Image per the exchange agreements with the PGs as defined in SDS/SDRL PC-005, Engineering Drawings and Associated Lists. This SDRL defines the format of the file, header information required when sending the file, naming convention of the file, etc.
- (1) A size, bookform drawings (e. g., documents) shall be delivered in a Printerleaf compatible format. Printerleaf is a standard file format that is compatible with several applications. MSWord, Interleaf, and ASCII text files are all compatible with Printerleaf.

- (2) All test data shall be delivered as an ASCII delimited file. Each column and field must be defined as well as how the file as a whole relates to part numbers, part instance, flight, etc.
- (3) Graphs produced for analysis and test reports are typically generated by computer software and digital measurement equipment. It is likely that the same software used to generate graphical data will also produce ASCII formatted outputs. Data providers are encouraged to contact their instrument suppliers for software and hardware solutions. In the event these solutions seem prohibitively expensive, there are manual means for the digitization of hardcopy plots. These methods are typically expensive and seriously degrade the accuracy and resolution of the data.

D.7 CATDB DATA FLOW

The CATDB data flow is a series of data exchanges.

- A. Exchange 1 is the bulk of raw data and drawings. It contains test results, analyses, wiring diagrams, and other information that contributes to assessing the EME.
- B. Exchange 2 contains Exchange 1 information and additional analyses and data for GFE and equipment developed by the PGs and IPs. This data is formally submitted between Data Management Groups and will not be loaded into the VMDB until the approval process is complete.
- C. Exchange 3 is via a virtual link. The data resides in the VMDB in tables or as datasets and drawings in the library. As different end users will require different data formats or contents, the CATDB will be necessary to meet ad hoc needs. The CATDB should retain the VMDB's library and GUI functions to support the transfer of drawings and additional data sets.
- D. Exchange 4 will vary in content and format to meet the user's needs. ISEAS and IEMCAP are the best defined users of this data and their input requirements will drive the design of the associated VMDB tables and content of data Exchange 1 and Exchange 2.

D.8 CATDB DATA CONTENT

Configuration data to be submitted should include, but not be limited to, equipment and rack location (X, Y, and Z offsets relative to rack or module origin), cabling attributes including length, routing, and termination, wire attributes including size, description, number of conductors, shield type, thickness, and termination, dielectric type and thickness, resistance, inductance, functional type (from Interface Control Document (ICD) or equivalent), EMC category, length, and cross referencing to match wire components to cable bundles. In addition to the data submitted in tabular form, drawings indicating the configuration should be included. Data providers will provide sufficient detail on their coordinate system to support the Prime in development of a common coordinate system.

Test data should include, but not be limited to, the testing indicated in the EMI Test Report as outlined in SDS-VE-0059A or as negotiated with the IPs. Data files should include the tabulation of graphical test data, specification value of parameters, the source of that value, and justification for omission of any required testing. In the case of GFE and IP developed hardware, other tests may be included.

D.9 CATDB DEVELOPMENT

The Prime will develop, along with the CATDB end users, the required structure of the outputs from the CATDB, which will drive the structure of related VMDB tables. The structure of these VMDB tables will be made available to data providers at the HWPs, PGs, IPs, and providers of GFE. Data providers will format their data as closely as possible to the VMDB structure and, in the event of incompatibilities, coordinate solutions with the Prime.

APPENDIX E MODIFICATIONS TO MIL-STD-1576

In the event of conflict, the requirements of this document supersede those requirements in MIL-STD-1576 Basic Revision, July 31, 1984, and Notice 01, September 4, 1992, as applied to the ISS. The intent is to provide ISS specific clarification of the requirements of MIL-STD-1576 rather than replacement of those requirements.

E.1 MODIFICATIONS TO SECTION 4.0

The paragraph number in MIL-STD-1576 is to be replaced by the paragraph as shown below.

A. 4.3 BONDING

- (1) The bonding requirements specified in SSP 30245 shall be applied.

B. 4.4 ELECTROEXPLOSIVE SUBSYSTEMS ELECTROMAGNETIC COMPATIBILITY

(1) 4.4.1 Inadvertent activation

- a. The electroexplosive subsystem shall limit the power produced at each EED by the radiated electromagnetic effect, defined in SSP 30237 for RS03, acting on the subsystem to a level at least 20 dB below the maximum pin to pin direct current (dc) no fire power of the EED.
- b. Under the same conditions stated in 4.4.1a, the electroexplosive subsystem shall limit the power produced at each device (exclusive of EEDs) in the firing circuit to a level at least 6 dB below the minimum activation power for each of the safety devices.

(2) 4.4.2 Direct Coupling to the EED and EES.

- a. EEDs shall not fire when the EES is subjected to the test requirements of SSP 30237, CS02.

E.2 MODIFICATIONS TO SECTION 5.0

The paragraph number in MIL-STD-1576 is to be replaced by the paragraph as shown below.

A. 5.2 SHIELDS

- (1) The firing circuit including the EEDs shall be completely shielded and shall not have RF apertures. Shielding effectiveness shall be demonstrated by test to be 6 dB for circuitry excepting EEDs and wiring to EEDs. EEDs and EED wiring shall be demonstrated to have a 20 dB margin by test, a 34 dB margin by test, or a 34 dB margin by analysis.
- (2) Cable shielding shall provide a minimum of 85 percent of optical coverage and shall be a minimum of three skin depths thick at the lowest threat frequency. The method for determining optical coverage shall be in accordance with FED-STD-228 or Federal QQ-B-575.
- (3) Shields shall not be used as intentional current carrying conductors and shall be multipoint grounded.
- (4) Not applicable.

B. 5.4 CABLES

- (1) Electroexplosive circuit cables shall be individually shielded when bundled in a common cable and a 20 dB isolation requirement shall be applied to coupling between any two or more cables. An overshield of the bundled cable shall be used to provide shielding from external sources where required.

C. 5.7.1 WIRING

- (1) EED firing sources shall be single point grounded and the firing signal to EEDs shall be balanced with respect to ground.

APPENDIX F APPROVED TAILORING/INTERPRETATION AGREEMENTS

EMECB TIA-0042

F.3.2.9 STATIC ELECTRICITY

Exception: The Payload Ethernet Hub Gateway (PEHG) (Configuration Item (CI) 222066A) is allowed to use the Rack Interface Controller (RIC) chip which is not qualified to the ESD levels.

Rationale: There is only one manufacturer of the RIC chip used in the PEHG design. The input and output connector pins are associated with the Attachment Unit Interface (AUI) which is not used on-orbit. The PEHG units have ESD labeling, in accordance with MIL-STD-1686, warning of potential damage by electrostatic discharges between 4000 and 15000 volts.

EMECB TIA-0060

F.3.2.2 SYSTEM, SUBSYSTEM, AND EQUIPMENT REQUIREMENTS

Exception: The Ammonia Servicer (Part Number (PN) GS5-00421-001) is exempt from meeting the MIL-STD-461C, Part 10, UM05 radiated emission limits between 150 kHz and 400 MHz. In addition the measured ambient may be exceeded by up to 10 dB between 150 kHz and 100 MHz.

Rationale: Measurements could not be made in a shield room. The ambient measured was higher than the UM05 limit. The source of the ambient emissions was determined to be a touch screen on the integral costs controller. Additional testing was done to determine the physical envelope of the broadband radiation. This testing indicated a radiation envelope of 3 meters. At 3 meters UM05 levels were not exceeded during equipment operation. Operational constraints will be imposed to restrict the placement of critical hardware within this envelope.

EMECB TIA-0061

F.3.2.2 SYSTEM, SUBSYSTEM, AND EQUIPMENT REQUIREMENTS

Exception: The Ammonia Servicer (PN GS5-00421-001) is exempt from meeting the MIL-STD-461C limits between the ranges of 190 kHz to 250 kHz and 450 kHz to 600 kHz.

Rationale: The DC power for this equipment is provided by a piece of Kennedy Space Center (KSC) GSE (PN GS5-00650-001). The EMI testing was performed using this DC source and no degradation of operation was found.

EMECB TIA-0091 (SUPERCEDED BY EMECB TIA-0196)

F.3.2.3 ELECTROMAGNETIC INTERFERENCE SAFETY MARGINS FOR CRITICAL CIRCUITS

Exception: The Rack Insertion Device (RID) (PN GH5-00191) is allowed to exceed the MIL-STD-461C, Part 10, UM05 1 meter broadband distance limit by up to 28 dB from 150 kHz to 10 MHz during operation.

Rationale: The RID stay out zone is 10 meters during its operation. No other equipment is powered up within this zone during RID operation. Test data taken at the 10 meter limit indicated that radiated emissions exceeded the limits defined by UM05 between the ranges of 150 kHz to 240 kHz (highest peak at 7 dB over the limit) and 500 kHz to 800 kHz (highest peak at 10 dB over the limit). A minimum of 48 dB margin exists between RE02 and RS03 limits so the exceedances at 10 meters are acceptable.

EMECB TIA-0092

F.3.2.2 SYSTEM, SUBSYSTEMS, AND EQUIPMENT REQUIREMENTS

Exception: The RID (PN GH5-00191) is allowed to exceed the MIL-STD-461C, Part 10, UM05 CE requirements by 45 dB from 150 kHz to 27 MHz.

Rationale: When the RID is in operation, no other equipment, including equipment in the racks, is powered up on the same bus as the RID. The RID itself is protected with an isolation transformer, RF EMI gasketing around doors, wire mesh to fill all vents, and shielding on all open conductors.

EMECB TIA-0195

F.3.2.2 SYSTEM, SUBSYSTEMS, AND EQUIPMENT REQUIREMENTS

Exception: For the Module Access Certification Equipment (MACE) (PN GA5-00871) at the frequency of 630 kHz, raise the MIL-STD-461C, Part 10, UMO5 limit of 102 dB by 1 dB.

Rationale: The MACE will be operated very infrequently (twice per year). The 0.5 dB radiated emissions is expected to fall below the UM05 test limit within the operational stay out zone of 1.5 meters from the MACE Motor Control Station. No other equipment will be powered within this zone during MACE operations.

EMECB TIA-0196

F.3.2.2 SYSTEM, SUBSYSTEMS, AND EQUIPMENT REQUIREMENTS

Exception: The RID (PN GH5-00191) is allowed to exceed the MIL-STD-461C, Part 10, UM05 1 meter broadband distance limit by up to 10 dB from 900 kHz to 10 MHz during operation. (This TIA supercedes EMECB TIA-0091 and changes the 10 meter stay out zone to a 6.5 meter stay out zone.)

Rationale: The RID stay out zone is 6.5 meters during its operation. No other equipment is powered within this zone during RID operation. Extrapolation of the test data taken at the one meter limit to the 6.5 meter distance indicates that the radiated emissions do not exceed the limits defined by UM05.

EMEP TIA-0230**F.3.2.9 STATIC ELECTRICITY**

Exception: The Active Rack Isolation System (ARIS) (PN 684-10158, CI 683L55A) is allowed to meet the ESD requirement of 3.2.9 at a level of 210 volts on connector J1 of the Actuator Assembly (light emitting diode (LED) and position sensor photodetector), 1500 volts on connector J1 of the Controller Assembly (MIL-STD-1553B address line pins), and 1000 volts on connector J1 of the Remote Electronics Unit (RS-232 test connector).

Rationale: Analysis of the ESD susceptibility of the ARIS components shows that three items do not meet the minimum 4000 volts requirement of 3.2.9. Only three affected connectors would be mated on orbit. Connections to the others would be made only on the ground. Observance of standard ESD handling precautions would prevent ESD damage to these assemblies. The ARIS is criticality 3 and its failure will not cause a safety hazard or interfere with other equipment.

EMEP TIA-0233**F.3.2.2 SYSTEM, SUBSYSTEMS, AND EQUIPMENT REQUIREMENTS**

Exemption: The RID (PN GH5-00191) is allowed to exceed the MIL-STD-461C, Part 10, UM05 1 meter broadband distance limit by up to 10 dBb from 900 kHz to 10 MHz during operation. (Reference TIA-0091: Change 10 meter stay out zone to 6.5 meter stay out zone.) (Reference EMECB TIA-0196: Change 6.5 meter stay out zone to 4 meter stay out zone.)

Rationale: The issues and limits listed in this TIA are identical to those of TIA 0196. The operational stay out zone has been reduced to within 4 meters of the RID. An EMI stay out zone will be established at the 4 meter point, as measured from the skin of the RID, within which no mission critical hardware will be powered without first verifying nonsusceptibility per the limits listed above. Test data taken at 1 meter and extrapolated to a distance of 4 meters indicates that radiated emissions do not exceed the ambient levels measured during testing.

EMEP TIA-0248**F.3.2.9 STATIC ELECTRICITY**

Exception: The Material Science Research Rack Master Controller (MC) is allowed to use RS232 and Common On-chip Processor (COP) devices that are not qualified to 3.2.9 and SSP 57000, paragraph 3.2.4.5.

Rationale: The MC RAD6000 RS232 and COP interfaces are brought out on connector pins for ground checkout purposes only. Connectors to these pins are capped during on-orbit operations. The MC will have ESD labeling, in accordance with MIL-STD-1686, warning of potential damage by electrostatic discharges between 4000 and 15000 volts.

EMEP TIA-0274**F.3.2.9 STATIC ELECTRICITY AND
F.3.2.13 CORONA**

Exception: The Video Tape Recorder (VTR), TEAC V-80AB-F (IF-101A), (PN 683-51020, CI 683-138A) is not required to meet the ESD requirements in 3.2.9. The VTR Orbital Replacement Unit (ORU) will be labeled as ESD sensitive and handled accordingly.

The VTR, TEAC V-80AB-F (IF-101A) is not required to meet the corona requirements in 3.2.13.

Rationale: ESD: Certify the TEAC COTS VTR Deck as ESD sensitive approved on the rationale it is used in industry and military applications and has no known ESD damage issues.

Corona: The TEAC COTS VTR Deck is supplied by low voltage power (28 Vdc) and is not required to operate below the normal shirt sleeve pressure in the United States Laboratory (USL). No damaging or destructive corona is expected under these conditions.

EMEP TIA-0289**F.3.2.9 STATIC ELECTRICITY**

Exception: The Radiation Suite equipment listed:

Human Resource Facility (HRF) DOSMAP Dosimetric Telescope 1 (DOSTEL1.F)

HRF DOSMAP Dosimetric Telescope 2 (DOSTEL2.F)

HRF DOSMAP Power Distribution Unit (PDU.F)

Dosimetric Mapping - E094 Control and Interface Unit (Liulin-CIU.F)

HRF DOSMAP DOSTEL 1 Power Cable (DOSTEL1PowerCable.F)

HRF DOSMAP DOSTEL 2 Power Cable (DOSTEL2PowerCable.F)

HRF DOSMAP DOSTEL 1 Data Cable (DOSTEL1DataCable.F)

HRF DOSMAP DOSTEL 2 Data Cable (DOSTEL2DataCable.F)

HRF DOSMAP CIU Power Cable (CIUPowerCable.F)

HRF DOSMAP CIU Data Cable (CIUDataCable.F)

HRF DOSMAP TLD Power Cable (TLDPowerCable.F)

HRF DOSMAP TLD Data Cable (TLDDataCable.F)

DOSMAP Mobile Dosimetry Unit 1 (Liulin-MDU1.F)

DOSMAP Mobile Dosimetry Unit 2 (Liulin-MDU2.F)

DOSMAP Mobile Dosimetry Unit 3 (Liulin-MDU3.F)

DOSMAP Mobile Dosimetry Unit 4 (Liulin-MDU4.F)

DOSMAP Nuclear Track Detector Package 1 (NTDP1.F)

DOSMAP Nuclear Track Detector Package 2 (NTDP2.F)

DOSMAP Nuclear Track Detector Package 3 (NTDP3.F)

DOSMAP Nuclear Track Detector Package 4 (NTDP4.F)

DOSMAP Nuclear Track Detector Package 5 (NTDP5.F)

Computer based Training PCMCIA cards (To Be Determined (TBD))

Computer based Training Computer Disk (CD) ROM disks (PN SDG46117524-301, 303, 305)

Backup SW CD (PN SDG46117131-301)

Detector, Velcro Assembly (PN SED46113556-311)

Dual Switch Box Assembly (PN SEG46116937-301)
CPDS Box Assembly (PN SED46116698-303)
Harness Assy, CPDS to Tissue Equivalent Proportional Counter (TEPC) Power Box (PN SED46115035-301)
Charged Particle Directional Spectrometer (CPDS) Data Cable Assembly (PN SEG46117172-301)
Active Dosimeter Data Cable Assembly (PN SED46117179-301)
TEPC Data Cable Assembly (PN SEG46116944-301)
Altered Item Drawing, Spectrometer Assembly (PN SED46113558-311)
TEPC Power Cable Assembly (PN SEG46116943-301)
Phantom Torso Assembly (PN SEG46117176-301)
Head (PN SEG46117170-301)
Chest (PN SEG46117170-303)
Abdomen (PN SEG46117170-305)
Bonner Ball Unit (PN T6-23000-101)
Bonner Ball Flight Harddrive (PN T6-23037-101) does not need to meet the 3.2.9 requirements. This requirement is in SSP 57000, paragraph 3.2.4.5.

Rationale: HRF Radiation Suite hardware contains COTS electronics which may be damaged by the application of 4000 volts to pins. Radiation Suite hardware is criticality 3 hardware. Any failure due to electrostatic discharge will not cause a safety hazard or interfere with other equipment. HRF Radiation Suite hardware uses standard commercial or military specification connectors. Pins in these connectors are recessed reducing the likelihood of the hardware experiencing electrostatic discharge. There are no operational constraints. The HRF Program and Principle Investigators accept the risk of science loss due to ESD.

EMEP TIA-0290

F.3.2.9 STATIC ELECTRICITY

Exception: The HRF Power Converter (PN SEG46117242-303) and HRF Power Strip (PN SEG46117243-301) do not need to meet the 3.2.9 requirements. This requirement is in SSP 57000, paragraph 3.2.4.5.

Rationale: HRF Power Converter and Power Supply hardware contains electronics which may be damaged by the application of 4000 volts to pins. HRF Power Converter and HRF Power Strip hardware is criticality 3 hardware. Any failure due to electrostatic discharge will not cause a safety hazard or interfere with other equipment. HRF Power Converter and Power Strip hardware uses standard commercial or military specification connectors. Pins in these connectors are recessed reducing the likelihood of the hardware experiencing electrostatic discharge. The HRF Program and Principle Investigators accept the risk of science loss due to ESD.

EMEP TIA-0291**F.3.2.13 CORONA**

Exception: The Radiation Suite equipment CPDS Box Assembly (PN SED46116698-303), Spectrometer Assembly (PN SED46113558-311), and Bonner Ball Unit (PN T6-23000-101) do not need to meet the 3.2.13 requirement. This requirement is in SSP 57000, paragraph 3.2.4.8.

Rationale: HRF Radiation Suite hardware will have no planned operation in any pressure environment other than that which is nominally planned for Intravehicular Activity (IVA) operations on board ISS. CPDS and TEPC have internal voltages as high as 700 Vdc. The Bonner Ball Unit has internal voltages as high as 1000 Vdc. A pressure environment conducive to corona will occur only in the event of an unplanned depressurization event when the hardware is receiving power. Since all voltages above 190 Vdc are contained inside a single payload item and no cables transfer greater than 190 Vdc between payload items and other payload items and ISS interfaces, any corona damage would be contained within the payload item containing the voltage greater than 190 Vdc and not propagate to ISS hardware or the crew. There are no operational constraints.

EMEP TIA-0302**F.3.2.9 STATIC ELECTRICITY**

Exception: The HRF Rack 1 equipment listed:

HRF Rack 1 (PN SEG46117303-303)

Unit Assembly (PN SEG46114550-302)

GASMAP Analyzer Module (PN SEG46117920-301)

Calibration Module, HRF GASMAP Altered Item Drawing (PN SDG46116916-802)

Cooling Stowage Drawer (PN SEG46117144-301)

Ultrasound Keyboard Module Assembly – Controller (PN SEG46115845-302)

Transducer Probe Assembly – Altered Item Drawing (PN SDG46114536-801)

Ultrasound Microphone Assembly – Altered Item Drawing (PN SDG46117020-801)

Ultrasound Headphone Assembly – Altered Item Drawing (PN SDG46117021-801)

HRF Common Battery Packs (PN DC2030-00XX)

HRF Flat Screen Display (PN FP1610HB/R-06)

WS PCMCIA card reader/writer assembly (PN SEG46114886-302)

Light Weight Headset Assembly (PN SEG46115679-701)

SCSI hard drive assembly VEG/HRF (PN SEG46115663-305)

SCSI hard drive assembly VEG/HRF (PN SEG46115663-306)

Keyboard Workstation (PN SEG46114997-801)

Audio Equalizer System Assembly – Altered Item Drawing (PN SDD46116385-302)

SCSI hard drive assembly VEG/HRF (PN SEG46115663-302)

SCSI harddrive assembly VEG/HRF (PN SEG46115663-303)

SCSI hard drive assembly VEG/HRF (PN SEG46115663-304) do not need to meet the 3.2.9 requirements. This requirement is in SSP 57000, paragraph 3.2.4.5.

Rationale: HRF Rack 1 hardware contains electronics which may be damaged by the application of 4000 volts to pins. HRF Rack 1 hardware is criticality 3 hardware. Any failure due to electrostatic discharge will not cause a safety hazard or interfere with other equipment. HRF Rack 1 hardware uses standard commercial or military specification connectors. Pins in these connectors are recessed reducing the likelihood of the hardware experiencing electrostatic discharge. In addition, the HRF rack mounted hardware remains grounded while mounted in the rack reducing the chance of damage due to ESD. HRF will assume responsibility for determining if the risk of damage due to ESD requires the inclusion of ESD handling techniques in HRF procedures. The HRF Program and Principle Investigators accept the risk of science loss due to ESD.

EMEP TIA-0304

F.3.2.13 CORONA

Exception: The HRF Rack 1 GASMAP Analyzer Module (PN SED46117920-301) and Workstation Flat Screen Display (PN FP1610HB/R-06) do not need to meet the 3.2.13 requirements. This requirement is in SSP 57000, paragraph 3.2.4.8.

Rationale: HRF Rack 1 hardware will have no planned operation in any pressure environment other than that which is nominally planned for IVA operations on board ISS. GASMAP Analyzer Module has internal voltages as high as 5200 Vdc. Workstation Flat Screen Display has internal voltages as high as 1400 Vdc which are only present for less than 1 second when the Flat Screen Display backlight is first activated. The internal voltages for the Flat Screen Display return to 24 Vdc following the 1 second backlight transient. The GASMAP Analyzer Module also contains small amounts of calibration gases and crew exhalate. These gases are designed to operate using corona in the presence of the calibration gases and crew exhalate and will not present a safety hazard. The GASMAP Calibration Module contains gases, but they are isolated from the GASMAP Calibration Module voltages which power the solenoid valves (12 Vdc). A pressure environment conducive to corona will only occur in the event of an unplanned depressurization event when the hardware is receiving power. Since all voltages above 190 Vdc are contained inside a single payload item and no cables transfer greater than 190 Vdc between payload items and other payload items and ISS interfaces, any corona damage would be contained within the payload item containing the voltage greater than 190 Vdc and not propagate to ISS hardware or the crew. There are no operational constraints.

EMEP TIA-0316

F.3.2.13 CORONA

Exception: The HRF Rack 1 Ultrasound (PN SEG46114550-302) does not need to meet the 3.2.13 requirement. This requirement is in SSP 57000, paragraph 3.2.4.8.

Rationale: HRF Rack 1 hardware will have no planned operation in any pressure environment other than that which is nominally planned for IVA operations on board ISS. Ultrasound has internal voltages as high as 1000 Vdc for 1 ms during turn on. A pressure environment conducive to corona will only occur in the event of an unplanned depressurization event when the hardware is receiving power. Since all voltages above 190 Vdc are contained inside a single payload item and no cables transfer greater than 190 Vdc between payload items and other payload items and ISS interfaces, any corona damage would be contained within the payload item containing the voltage greater than 190 Vdc and not propagate to ISS hardware or the crew. There are no operational constraints.

EMEP TIA-0367

F.3.2.9 STATIC ELECTRICITY

Exception: The ARIS (PN 684-10158, CI 683L55A) is allowed to meet the ESD requirement of 3.2.9 at a level of 210 volts on connector J1 of the Actuator Assembly (LED and position sensor photodetector), 1500 volts on connector J1 of the Controller Assembly (MIL-STD-1553B address line pins), and a level of 1000 volts on connector J1 of the Remote Electronics Unit (RS232 test connector).

Rationale: Analysis of the ESD susceptibility of the ARIS components shows that three items do not meet the minimum 4000 volt requirement of 3.2.9. Only three affected connectors will be mated on orbit. Connections to the others will be made only on the ground. Observance of standard ESD handling precautions would prevent ESD damage to these assemblies. The ARIS is criticality 3.

The most sensitive connector is J1 on the Actuator Assembly where pins connect to a photosensor position sensing device. This device is not affected to at least 210 volts and may not be affected to at least several hundred volts. On orbit, two Actuator Assemblies must be attached and connected by the crew during ISPR or EXPRESS Rack installation. Observance of routine ESD handling precautions should avoid any ESD damage to this device.

The MIL-STD-1553B address line pins on the Controller Assembly J1 connector are mated only on the ground and are known to not be affected to at least 1500 volts. Observance of routine ESD handling precautions should avoid any ESD damage to this device.

The RS-232 pins on the Remote Electronics Unit J1 connector are used only on the ground for certain test and maintenance operations. This connector is mated on the ground. Observance of routine ESD handling precautions should avoid any ESD damage to this device.

EMEP TIA-0369**F.3.2.9 STATIC ELECTRICITY**

Exception: The Pulmonary Function In Flight (PuFF) equipment listed (DSR PCMCIA Card (PN SED46115614-303 or PN SED46115614-305) and Electrocardiogram (ECG) electrodes (PN 7663)) do not need to meet the SSP 30237, paragraphs 3.2.2.1, 3.2.2.2, 3.2.2.3, 3.2.4.1, and 3.2.4.2 requirements. These SSP 30237 requirements are contained in SSP 57000, paragraph 3.2.4.4. The PuFF equipment listed (Pressure Flow Module (PN 44100), Pulse Frequency Modulation (PFM) Data Cable (PN 44150), 8MB Flash Storage Card (PN DP-ATA/B), Fleisch #2 Flowmeter Assembly (PN 44250), ECG Electrodes Pack (PN SDG46117695-801), Assembly, Single Housing PSC Unit (PN SEG46117965-801), Cable Assembly W16 - PSC ECG Data (PN SED46112486-303), Cable Assembly ECG Electrodes Leads (PN SED46113083-303), Battery Pack Assembly (PN SEG46117914-301), DSR PCMCIA Card (PN SED46115614-303 or PN SED46115614-305), and ECG electrodes (PN 7663)) do not need to meet the 3.2.9 requirements. These requirements are in SSP 57000, paragraph 3.2.4.5.

Rationale: Susceptibility – PuFF is criticality 3 hardware. Any failure due to susceptibility will not cause a safety hazard or interfere with other equipment. PuFF equipment is located downstream of the HRF Rack Solid State Power Control Module (SSPCM) which should provide significant protection from ISS ESP transients. HRF plans to conduct abbreviated functional tests of the integrated PuFF hardware using the HRF Rack prior to hardware delivery. This should provide some evidence of ability to withstand conducted transients. The HRF Program and Principal Investigators accept the risk of science loss due to radiated or conducted susceptibility. There are no operational constraints. The ECG electrodes (PN 7633) are a subassembly of the ECG Electrodes Pack (PN SDG46117695-801) approved in TIA-0348A.

ESD – PuFF hardware contains electronics which may be damaged by the application of 4000 volts to pins. PuFF hardware is criticality 3 hardware. Any failure due to electrostatic discharge will not cause a safety hazard or interfere with other equipment. PuFF hardware uses standard commercial or military specification connectors. The PuFF equipment has connector covers, female connectors, or recessed connectors which will protect the PuFF electronics from ESD until PuFF cabling is connected to other HRF hardware. Once the PuFF hardware is connected to other HRF hardware, it remains redundantly grounded (ground wire and shield) reducing the chance of damage due to ESD. HRF will assume responsibility for determining if the risk of damage due to ESD requires the inclusion of ESD handling techniques in HRF procedures. The HRF Program and Principal Investigators accept the risk of science loss due to ESD. There are no operational constraints.

EMEP TIA-0379**F.3.2.9 STATIC ELECTRICITY**

Exception: The equipment unique to the HRF EVARM experiment (EVARM Reader (PN 600-100027), Radiation Badges (PNs 600-100028, 600-100029, and 600-100030), HRF Power Converter (PN SEG46117242-303), HRF Laptop (PN SDG39129262-301), Power Cable (PN SEG39129263-301), RS232 Cable (PN SEG46117035-301), HRF Common 28 Vdc Cable (PN SEG46115683-301), Power Cable (PN SEZ39129260-305), PWR Supply 120-16 Vdc (PN SEG39129272-303), and Power Cable 120 Vdc (PN SEG46116745-301) do not need to meet the 3.2.9 requirements. These requirements are in SSP 57000, paragraph 3.2.4.5.

Rationale: The HRF EVARM experiment unique equipment contains electronics which may be damaged by the application of 4000 volts to pins. The HRF EVARM experiment unique equipment is criticality 3 hardware. Any failure due to electrostatic discharge will not cause a safety hazard or interfere with other equipment. The HRF EVARM experiment unique equipment uses standard commercial or military specification connectors. Pins in these connectors are recessed reducing the likelihood of the hardware experiencing electrostatic discharge. HRF will assume responsibility for determining if the risk of damage due to ESD requires the inclusion of ESD handling techniques in HRF procedures. The HRF Program and Principal Investigators accept the risk of science loss due to ESD.

EMEP TIA-0384**F.3.2.2 SYSTEM, SUBSYSTEM, AND EQUIPMENT REQUIREMENTS**

Exception: The Multiplexer-Demultiplexer (MDM) Solid State Mass Memory Unit (SSMMU) (CI 222002A, PN 8259015-914) will be qualified by similarity to the requirements of 3.2.2. The SSMMU will be qualified by similarity to the previously qualified MDM that uses a disk memory system.

Rationale: The MDM containing the SSMMU is being qualified by its similarity to the MDM using the mass storage device. Both systems use Circuit Card Assemblies that incorporate multilayer board design and separate board layers or wide trace runs that are dedicated for power, signal, analog signal return, and chassis ground. Sensitive signals are routed between solid board layers. A minimum of 30 dB shielding is provided for sensitive signals and nearby boards. An Enhanced Space Station MDM (ESSMDM) containing a SSMMU will have the same input cabling, the same internal low voltage converter, the same output signal characteristics, and the same Faraday cage chassis packaging. The new configuration will not be any more sensitive to externally generated EMI (radiated or conducted noise generated outside of ESSMDM) than the present configuration. The SSMMU will be inside a well shielded MDM case. Only the external interface is loop back wiring that is routed external to the MDM case. The previous ground bounce issue is addressed by the addition of capacitors on card to provide AC coupling between the digital signal ground (used by the High Rate Data Link (HRDL)) and the logic signal ground (used by the SSMMU) and eliminate differential voltage between the two cards. Loop back wiring in four of five USL rack locations and HRDL and Command and Control software was modified to recover from parity errors and transaction timeouts. Hysteresis of 54ACTQ14 devices on the SSMMU Controller card ignores glitches due to the Acknowledge Signal (ACK) signal.

EMEP TIA-0419

F.3.2.2 SYSTEM, SUBSYSTEM, AND EQUIPMENT REQUIREMENTS

Exception: The Gantry Crane (PN 82K07010 and PN 82K07032) is allowed to exceed the MIL-STD-461C, Part 10, UM05 conducted emissions limit by 8 dB from 430 kHz to 1.3 Mhz.

Rationale: The exceedance is minor and should not present a problem since the hoist will not share power with flight hardware and will not damage flight hardware.

EMEP TIA-0420

F.3.2.2 SYSTEM, SUBSYSTEM, AND EQUIPMENT REQUIREMENTS

Exception: The Tilt Platform Assembly (TPA) (PN 82K07127 and PN 82K05671) is allowed to exceed the MIL-STD-461C, Part 10, UM05 conducted emissions limit by 6 dB from 675 kHz to 810 kHz.

Rationale: The exceedance is minor and should not present a problem since the TPA will not share power with flight hardware and will not damage flight hardware.

EMEP TIA-0422**F.3.2.9 STATIC ELECTRICITY**

Exception: The FOOT Experiment Unique Equipment (EUE) (ADAS1 Unit (PN SEG46117915-301), Marker Cable (PN SEG46118425-301), Flash Kit 440 (PN SJG46117707-301), JES Unit (Quantity 2) (PN SEG46117981-301), Ankle Sensor (PN SEG46118316-301), Knee Sensor (PN SEG46118315-301), Hip Sensor (PN SEG46118314-301), TF-FGI Box (PN SEG46118240-301), TF-FGI Insole (PN SEG46118241-317), TF-FGI Insole (PN SEG46118241-318), LEMS Data Cable (PN SEG46118164-301), LEMS Pant (PN SEG46118153-303), LEMS Armband (PN SEG46118161-303), and FCU Unit (PN SEG33110402-301)) is exempted from meeting the 3.2.9 requirements. These requirements are in SSP 57000, paragraph 3.2.4.5.

For the TF-FGI Insole (PN SEG46118241-317), TF-FGI Insole (PN SEG46118241-318), LEMS Pant (PN SEG46118153-303), and LEMS Armband (PN SEG46118161-303), the dash numbers will differ for each item since it is custom sized hardware.

Rationale: The FOOT EUE contains electronics which may be damaged by the application of 4000 volts to pins. The FOOT EUE is criticality 3 hardware. Any failure due to electrostatic discharge will not cause a safety hazard or interfere with other equipment. The FOOT EUE uses standard commercial or military specification connectors. Pins in these connectors are recessed to reduce the hardware from experiencing electrostatic discharge. The Human Resource Facility (HRF) will assume responsibility for determining if the risk of damage due to ESD requires the inclusion of ESD handling techniques in HRF procedures. The HRF Program and Principal Investigators accept the risk of science loss due to ESD.

APPENDIX G PAYLOAD EME REQUIREMENTS

G.1 LIGHTING

The integrated rack and EPCE shall meet the lightning induced environment requirement in 3.2.8.1. The lightning requirement shall be verified by analysis. The analysis shall be considered successful when the data shows that the integrated rack and EPCE are compatible with the requirements in SSP 57000, paragraph 3.2.4.9. Note: The analysis data should be based on end item qualification design data and analysis data of the integrated rack or EPCE.

G.2 CORONA

Electrical and electronic subsystems, equipment, and systems shall be designed to preclude damaging or destructive corona in its operating environment. Guidance for meeting the corona requirement is in MSFC–STD–531.

Equipment with voltages (steady state, transient, internal, or external) greater than 190 volts or equipment containing gaseous mixture other than those present in the pressurized module shall be verified by analysis or test to the degree necessary to ensure no permanent damaging effects and no hazardous conditions due to destructive corona will exist in its operating environment. The operating environment is defined as normal pressurized atmosphere as specified in SSP 57000, Table 3.9.4–1, or depressurized module if the payload is still powered. The fault clearing and protection voltage in SSP 57000, paragraph 3.2.1.3.3, is not considered the equipment voltage. If the equipment (with voltages greater than 190 volts) is to be powered during depressurization, the verification shall be accomplished by test.